RECEIVER WITH FREQUENCY RESPONSE IMPROVEMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates sound generating devices and, more particularly, to a receiver with frequency response improvement.

2. Description of the Related Art

FIG. 1 shows a conventional mini receiver **60**. The receiver **60** comprises a housing **62**, which is comprised of a barrel-like yoke holder **64**, a disk-like front cover plate **66** covering the front side of the yoke holder **64**, and disk-like rear cover plate **68** covering the rear side of the yoke holder **64**, a rear yoke **74** mounted inside the housing **62**, the rear yoke **74** having an annular base **76** spaced from the rear cover plate **68** at a distance and a tubular body **78** forwardly extended from the inner diameter of the annular base **76**, an annular magnet **82** disposed around the tubular body **78** of the rear yoke **74** without touching the periphery of the tubular body **78** and stopped at the front side of the annular base **76**, a front yoke **84** disposed around the tubular body **78** of the rear yoke **74** and stopped at the front side of the annular magnet **82**, a vibration diaphragm **86** stretched inside the housing **62** in front of the yokes **74** and **84**, a voice coil **88** connected to the back side of the vibration diaphragm **86** at the center and suspended in the annular space between the front yoke **84** and the tubular body **78** of the rear yoke **74**, and an acoustic paper **92** covering the rear open side of the tubular body **78** of the rear yoke **74**. When applying an audio signal to the voice coil **88**, the front yoke **84**, the magnet **82** and the rear yoke **74** form a magnetic loop, thereby causing the voice coil **88** to vibrate the vibration diaphragm **86** corresponding to inputted video signal subject to Fleming's left hand rule, and to further produce sound.

It is well known that frequency response is an important index to judge the performance of a receiver. A long extension of the flat segment of frequency response curve means that the receiver can receive input signal of a relatively higher frequency or relatively lower frequency and maintain a constant output power. According to the design of the aforesaid conventional receiver, a better performance of frequency response to low frequency is achieved when increasing the internal space, i.e. the flat segment of frequency response curve extends in direction toward relatively lower frequency. On the contrary, when reducing the internal space of the receiver, the low frequency performance becomes poor. Because the aforesaid conventional receiver is commonly used in mobile apparatus, for example, a cellular telephone, there is a space limitation, i.e., low frequency performance is poor. Further, the performance of frequency response of the aforesaid conventional receiver to high frequency is still not good enough due to the effect of materials used and the limitation of internal space. The curve of imaginary line shown in FIG. 3 is a frequency response curve obtained from the aforesaid conventional receiver **60**. As illustrated, the flat segment extends within the area between 300Hz and 4KHz, i.e., the output power of the receiver **60** drop drastically upon an input signal of frequency below 300Hz or over 4KHz.

Therefore, it is desirable to provide a receiver that eliminates the aforesaid drawbacks.

SUMMARY OF THE INVENTION

The present invention has been accomplished under the circumstances in view. It is therefore the main object of the present invention to provide a receiver, which has the flat segment of the frequency response curve extended wider, i.e., the receiver is capable of receiving input signal of relatively higher or relatively lower frequency and keeping a constant output power.

To achieve this object of the present invention, the receiver comprises a housing having a front side, a rear side, and a plurality of sound holes extended through the front side; a rear yoke mounted inside the housing, the rear yoke having an annular base spaced from the rear side of the housing at a distance, and a tubular body forwardly extended from an inner diameter of the annular base; an annular magnet disposed around the tubular body of the rear yoke and stopped at a front side of the annular base; a front yoke disposed around the tubular body of the rear yoke and stopped at a front side of the annular magnet; a vibration diaphragm mounted inside the housing and stretched in front of the rear yoke and the front yoke; a voice coil connected to a back side of the vibration diaphragm and suspended in an annular space between the front yoke and the tubular body of the rear yoke; and a first acoustic paper bonded to the annular base of the rear yoke to block the tubular body of the rear yoke; wherein the housing has at least one air hole in the rear side and a second acoustic paper blocking the at least one air hole; a first cushion is mounted inside the tubular body of the rear yoke, the first cushion being a tubular member having the periphery thereof disposed in contact with an inner diameter of the tubular body of the rear yoke; a second cushion mounted in an annular gap between the annular magnet and the tubular body of the rear yoke, the second cushion being an annular member having inner and outer diameters respectively disposed in contact with a periphery of the tubular body of the rear yoke and an inner diameter of the annular magnet and spaced from the front yoke at a distance. According to an alternate form of the present invention, an annular step is formed integral with a connection area between the tubular body and annular base of the rear yoke to substitute for the aforesaid second cushion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a receiver according to the prior art.

FIG. 2 is a sectional view of a receiver according to a first preferred embodiment of the present invention.

FIG. 3 is a comparison chart showing a frequency response curve obtained from the receiver of the present invention and a frequency response curve obtained from the receiver of the prior art design.

FIG. 4 is a sectional view of a receiver according to a second preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 2, a receiver **10** in accordance with the first embodiment of the present invention is shown comprising:

a housing **12**, which is comprised of a barrel-like plastic yoke holder **14**, a disk-like plastic front cover plate **16** covering the front side of the plastic yoke holder **14**, the plastic front cover plate **16** having a plurality of sound holes **22** extended through the front and back sides, and a disk-like plastic rear cover plate **18** covering the rear side of the plastic yoke holder **14**, the plastic rear cover plate **18** having an air hole **24** extended through the front and back sides at the center;

a rear yoke **26** mounted inside the housing **12**, the rear yoke **26** having an annular base **28** spaced from the rear cover plate **18** at a distance, and a tubular body **32** forwardly extended from the inner diameter of the annular base **28** and spaced from the plastic front cover plate **16** at a distance (according to this embodiment, the annular base **28** and the tubular body **32** are formed integral with each other; alternatively, the

annular base **28** and the tubular body **32** can be separately made and then fastened together without affecting the performance of the receiver);

an annular magnet **34** disposed around the tubular body **32** of the rear yoke **26** without touching the periphery of the tubular body **32** and stopped at the front side of the annular base **28**;

a front yoke **36** disposed around the tubular body **32** of the rear yoke **26** and stopped at the front side of the annular magnet **34**;

a vibration diaphragm **38** mounted inside the housing **12** and peripherally affixed to the front side of the yoke holder **14** in front of the yokes **26** and **36**;

a voice coil **42** connected to the back side of the vibration diaphragm **38** at the center and suspended in an annular space between the front yoke **36** and the tubular body **32** of the rear yoke **26**;

a coupling voice coil **44** mounted inside the housing **12** around the vibration diaphragm **38**;

a first acoustic paper **46** bonded to the annular base **28** of the rear yoke **26** to block the rear open side of the tubular body **32** of the rear yoke **26**;

a second acoustic paper **48** bonded to the plastic rear cover plate **18** of the housing **12** at the center to block the air hole **24** (the back side of the housing, i.e., the plastic rear cover plate **18** may be made having a plurality of air holes that are blocked by the second acoustic paper);

a first cushion **52** made of rubber and shaped like a tube and coaxially mounted inside the tubular body **32** of the rear yoke **26** to reduce the cross section of the passage (the bore of the tubular body **32**) between the front and rear sides of the rear yoke **26** and to enhance sound absorbing power, keeping the periphery in close contact with the inner diameter of the tubular body **32** and the front and rear ends in

flush with the front and rear ends of the tubular body **32**; and

a second cushion **54** made of rubber in annular shape and disposed around the tubular body **32** of the rear yoke **26** and stopped between the outside wall of the tubular body **32** and the inside wall of the magnet **34**, that is, the second cushion is mounted in an annular gap between said annular magnet **34** and the tubular body **32** of said rear yoke.

According to this embodiment, the axial thickness of the second cushion **54** is about one half of the magnet **34**, and the second cushion **54** is stopped at the front side of the annular base **28** of the rear yoke **26**, i.e., the distance between the front side of the second cushion **54** and the rear side of the front yoke **36** is about one half of the thickness of the magnet **24**. By means of the arrangement of the second cushion **54**, the depth of the gap from the vibration diaphragm **38** between the magnet **34** and the tubular body **32** is shortened.

The above description well describes the structural features of the receiver **10** according to the first embodiment of the present invention (remark: the arrangement of the vibration voice coil **42** and the coupling voice coil **44** is of the known art, no further detailed description in this regard is necessary). By means of the aforesaid structure, the flat segment of the frequency response curve of the receiver **10** extends relatively wider than conventional designs. In detail, the presence of the air hole **24** at the rear side of the housing **12** and the arrangement of the second acoustic paper **48** greatly improve frequency response to low frequency, i.e. the flat segment of the frequency response curve extends in direction toward lower frequency area. FIG. 3 is a comparison chart showing a frequency response curve obtained from the receiver **10** of the present invention and indicated by real line, and a frequency response curve obtained from the receiver of the prior art design and indicated by imaginary line. As

illustrated, the flat segment of the frequency response curve obtained according to the present invention extends to about 150Hz or even about 100Hz in low frequency area. In comparison to the sudden drop of the curve obtained according to the prior art design at 300Hz, the invention achieves a better performance at low frequency. Further, the arrangement of the two rubber cushions **52** and **54** changes the shape and material quality of the internal space of the receiver to reduce the inertia of the vibration diaphragm **38** during vibration, enabling the flat segment of the frequency response curve to extends in direction toward higher frequency area. As illustrated in FIG. 3, the frequency response curve obtained according to the present invention starts to drop after extended to 6k Hz at high frequency area. In comparison to the frequency response curve obtained according to the prior design that starts to drop at about 4k Hz, the invention achieves a better performance at high frequency.

As indicated above, the flat segment of the frequency response curve obtained according to the present invention extends relatively wider, i.e. the receiver of the present invention is capable of receiving input signal of relatively higher frequency and relatively lower frequency, and keeping a constant output power. Further, the improvement (structural characteristics) of the invention does not increase the dimension and thickness of the receiver, i.e., maintains the compact outer appearance of the receiver for use in cellular telephone or any of a variety of small apparatus.

FIG. 4 shows a receiver **10'** constructed according to the second embodiment of the present invention. Similar to the aforesaid first embodiment of the present invention, the receiver **10'** comprises a housing **12'**, a rear yoke **26'** at a rear side inside the housing **12'**, an annular magnet **34'** supported on the front side of the annular base **28'** of the rear yoke **26'**, a front yoke **36'** disposed at the front side of the annular magnet **34'**, a vibration diaphragm **38'** stretched in front of the front yoke **36'**,

a voice coil **42'** connected to the back side of the vibration diaphragm **38'**, and a first acoustic paper **46'** covering the rear open side of the tubular body **32'** of the rear yoke **26'**, a second acoustic paper **48'** covering the center air hole **24'** at the rear side of the housing **12'**, and a tubular rubber cushion **52'** fitted into the inside of the tubular body **32'** of the rear yoke **26'**. This embodiment eliminates the aforesaid second cushion **54**. To substitute for the aforesaid second cushion **54**, the tubular body **32'** of the rear yoke **26'** is made having an annular step **33** (comparing FIG. 4 to FIG. 2). The annular step **33** is formed integral with the connection area between the tubular body **32'** and the annular base **28'**, having the periphery disposed in contact with the inner diameter of the annular magnet **34'**. The axial thickness of the annular step **33** is one half of the thickness of the magnet **34'**. Therefore, the depth of the gap from the vibration diaphragm **38'** between the magnet **34'** and the tubular body **32'** is shortened. This embodiment achieves same frequency response improvement.